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THE

ECLIPSE OF THE SUN

OF

MAY 26, 1854.

From the Proceedings of the American Academy.

At the meeting of the American Academy of Arts and Sciences, March 14th, 1853, Mr. Paine made the following communication on the approaching eclipse of the sun: —

"On the afternoon of Friday, the 26th of May next, there will be an eclipse of the sun visible and generally large throughout the United States, and actually annular in part of the Territories of Washington and Minnesota, of Vancouver's Island, of Canada West, and of the States of Michigan, New York, Vermont, New Hampshire, Maine, and Massachusetts.

" A central, or very nearly central, solar eclipse, at any place, is indeed of rare occurrence. At the city of Paris only one takes place in the 133 years between 1767 and 1900, and although in Boston we have been more favored than Paris, the phenomenon in the century and a quarter between 1775 and 1901, and perhaps many more years, occurs here but four times; namely, in the annular obscurations of April 2, 1791; May 26, 1854; and September 28, 1875; and in that which was total, on June 16, 1806. The eclipse of February 12, 1831, was also annular at Nantucket and at Chatham, Cape Cod, but not elsewhere in New England.

" From computations, the results of which are more particularly given below, it appears that the path of the central eclipse of the 26th of May first enters upon the earth in the North Pacific Ocean near the Caroline Islands, in Lat. of about 6½° North, Long. 197° West; thence taking a northeasterly direction, it touches our continent near Cape Flattery in Washington Territory; it thence passes over Vancouver's Island, British Oregon, Minnesota, Isle Royale, Lake Superior, Canada West, New York, Vermont, New Hampshire, and Maine, to the Atlantic, where it leaves the earth in Lat. of about 36°, Long. 52°, having in $3^{h.}$ $41^{m.}$ $21^{s.}$, the time of its continuance thereon, run over 145½ degrees of longitude and 56 of latitude.

" It, moreover, appears that the duration of the ring, where central, in Washington Territory, is four and a half minutes, (which is nearly its longest duration at any place,) and in New York and New England somewhat less than four, although the ring is about ten seconds broader, and the distance between the lines of the northern and southern limits of the annular phase about thirty miles greater in the northeastern than in the northwestern part of the United States.

" In the Northeastern States, these limits will be well represented by lines drawn on a map, one from the southwestern part of the island of Montreal, over the southern part of the towns of Gardiner and St. George in Maine, to the ocean, and another from Ameliasburg in Canada West, over Ellisburg and Saratoga Springs in New York, Bennington, Vt., Leyden, Sterling, Dedham, Marshfield, and Orleans, in Massachusetts. These lines will be nearly parallel, and distant about 145 English miles, and will include between them the northeastern part of New York, nearly the whole of Vermont, all but the northern part of New Hampshire, the southwestern part of Maine, and, in Massachusetts, the northeastern part of the counties of Franklin, Worcester, Norfolk, Plymouth, and Barnstable, nearly the whole of Middlesex, and the whole of Suffolk and Essex. A third line, drawn nearly equidistant between the two others, from the southern part of Isle Royale in Lake Superior to Ogdensburg, N. Y., thence over Middlebury, Vt., Hanover, Sanbornton, Gilmanton, and Rochester, N. H., to the ocean at Cape Neddock in York, Maine, will represent the path of the *central* eclipse; as a fourth, from Gibraltar Point, near Toronto, C. W., over Delhi and Kingston, N. Y., Middletown, Conn., to Block Island, R. I., will that of the line of eleven digits of obscuration on the north limb of the sun.

"As sixty-three years have passed since the occurrence of the last annular eclipse in New England, and as in the last forty-six years of the present century only one more will take place, it is not doubted that the one of May 26th will be viewed with interest by every spectator; but it is hoped that those observers, within the limits of the ring, who may be provided with a good telescope, will give particular attention to the singular appearances which so often have been noticed at the second and third contacts, and which, in consequence of having been minutely described by the late Mr. Bailly, are known by his name, especially as there is some reason for the suspicion that these beads, &c. may be seen or not, at the pleasure of the observer, according as he employs a screen colored red or green.

"In the eclipse of February 12, 1831, which was viewed by the writer at the light-house on Monomoy Point, off Chatham, with a red screen, these beads were, just before the formation of the ring, so very conspicuous, that it was difficult to determine with precision when it actually took place, whilst in that which was annular in Washington in September, 1838, and that which was total near Savannah in November, 1834, these appearances could not be perceived by him, although carefully looked for through a screen composed of two glasses, one shaded light red, the other light green.

"Indeed, it is particularly desirable that at some places there will be two observers furnished with telescopes of nearly the same optical power, but with screens colored green and red, who, after the second contact, shall exchange their instruments for their observations on the third, and shall note carefully the appearances and phenomena by which each contact is attended.

"The elements of the moon used for the following computations (except the parallax and semidiameter) are the mean of the quantities deduced from the tables of Damoiseau and Burckhardt. Those of the latter were taken from the English and French Nautical Almanacs, but those of Damoiseau were computed for May 26th, 6, 8, 10, and 12 hours of Paris, and thence interpolated for every hour of the meridian of Greenwich. Whilst the difference of the tables in latitude is small, or about a second and a half, in longitude it is very considerable, or eleven seconds. For the parallax, that of Burckhardt was preferred, as corrected by Mr. Adams, one of the distinguished discoverers of the planet Neptune, who, in a memoir affixed to the Nautical Almanac for 1856, appears to have thoroughly investigated the subject.

Path of the Central Eclipse of the Sun over the Earth, Friday, May 26, 1854, *according to the Tables of Damoiseau and Burckhardt, for every Fifth Minute whilst crossing the North Pacific Ocean, and for every Minute of the Remainder of the Time of its Continuance on the Earth.*

Mean Time at Greenwich.

Mean Time Gr.	Eclipse Central in Lat. North.	Eclipse Central in Long. West.	Mean Time Gr.	Eclipse Central in Lat. North.	Eclipse Central in Long. West.
h. m. s.	° ′	° ′	h. m. s.	° ′	° ′
6 54 55	6 38	197 7	8 30 0	41 5	144 40
55 0	7 23	195 22	35 0	42 3	142 54
55 2	7 38	194 34	40 0	42 58	141 4
55 6	7 59	193 46	45 0	43 50	139 11
6 57 30	11 18	187 11	50 0	44 39	137 13
7 0 0	13 11	183 18	55 0	45 26	135 11
5 0	16 12	178 35	*8 55 55	45 34.1	134 47.6
10 0	18 37	174 43	9 0 0	46 10	133 2.9
15 0	20 45	171 40	5 0	46 50	130 50.0
20 0	22 40	169 15	10 0	47 27	128 30.3
25 0	24 26	167 0	15 0	48 0.5	126 3.5
30 0	26 5	164 57	16 0	48 6.7	125 33.4
35 0	27 39	163 2	9 17 0	48 12.8	125 3.0
40 0	29 8	161 14			
45 0	30 33	159 30	*Washington Territory.*		
50 0	31 55	157 50	9 18 0	48 18.7	124 32.3
7 55 0	33 14	156 12	19 0	24.4	124 1.3
8 0 0	34 29	154 35	20 0	30.0	123 30.1
5 0	35 41	152 58	21 0	35.4	122 58.5
10 0	36 51	151 21	22 0	40.6	122 26.6
15 0	37 58	149 44	23 0	45.7	121 54.3
20 0	39 3	148 5	24 0	50.5	121 21.7
8 25 0	40 5	146 24	9 25 0	48 55.2	120 48.9

* On the meridian of the place.

Mean Time Gr. h. m. s.	Eclipse Central in Lat. North. ° '	Eclipse Central in Long. West. ° '
9 26 0	48 59.7	120 15.8

British Oregon.

9 27 0	49 4.0	119 42.4
28 0	8.1	119 8.6
29 0	12.0	118 34.5
30 0	15.7	118 0.0
31 0	19.2	117 25.1
32 0	22.5	116 49.8
33 0	25.6	116 14.2
34 0	28.5	115 38.2
35 0	31.1	115 1.9
36 0	33.5	114 25.2
37 0	35.7	113 48.2
38 0	37.6	113 10.7
39 0	39.3	112 32.8
40 0	40.8	111 54.6
41 0	42.0	111 16.0
42 0	43.0	110 36.9
43 0	43.7	109 57.4
44 0	44.1	109 17·5
*45 0	44.3	108 37.1
46 0	44.2	107 56.3
47 0	43.8	107 15.0
48 0	43.1	106 33.2
49 0	42.0	105 50.9
50 0	40.6	105 8.1
51 0	39.0	104 24.9
52 0	37.0	103 41.1
53 0	34.7	102 56.8
54 0	32.0	102 11.9
55 0	28.9	101 26.4
56 0	25.5	100 40.4
57 0	21.7	99 53.8
58 0	17.5	99 6.5
9 59 0	12.9	98 18.6
10 0 0	7.9	97 30.1
1 0	49 2.5	96 41.0
2 0	48 56.6	95 51.1
3 0	50.2	95 0.4
10 4 0	48 43.3	94 8.9

N. E. Corner of Minnesota Terr.

10 5 0	48 35.9	93 16.6
6 0	28.0	92 23.2
7 0	19.5	91 28.8
10 8 0	48 10.4	90 33.5

Isle Royale, Lake Superior.

10 9 0	48 0.7	89 37.3

Lake Superior.

10 10 0	47 50.2	88 40.0
11 0	38.9	87 41.4
12 0	27.0	86 41.5
10 13 0	47 14.3	85 40.1

Canada West.

10 14 0	47 0.9	84 37.2
15 0	46 46.6	83 32.6
16 0	31.3	82 26.3
17 0	46 14.8	81 17.9
18 0	45 57.1	80 7.2
19 0	38.0	78 53.9
20 0	45 17.5	77 37.6
21 0	44 55.3	76 17.8
21 15	49.5	75 57.2
10 21 30	44 43.5	75 36.4

State of New York.

10 21 45	44 37.4	75 15.3
22 0	31.2	74 53.9
22 15	24.8	74 32.3
22 30	18.3	74 10.3
10 22 45	44 11.6	73 48.0

Lake Champlain.

10 23 0	44 4.8	73 25.4

State of Vermont.

10 23 15	43 57.8	73 2.4
23 30	50.6	72 39.0
10 23 45	43 43.3	72 15.3

State of New Hampshire.

10 24 0	43 35.7	71 51.2
24 15	27.9	71 26.7
10 24 30	43 19.9	71 1.8

State of Maine.

10 24 45	43 11.6	70 36.2

Atlantic Ocean.

10 25 0	43 3.2	70 10.1

* Greatest north latitude of the central path.

Mean Time Gr.	Eclipse Central in Lat. North.	Eclipse Central in Long. West.	Mean Time Gr.	Eclipse Central in Lat. North.	Eclipse Central in Long. West.
h. m. s.	° ′	° ′	h. m. s.	° ′	° ′
10 26 0	42 26.4	68 18.2	10 30 0	37 54.2	55 58.6
27 0	41 43.7	66 13.9	30 12	37 5.7	53 56.7
28 0	40 52.4	63 48.9	30 15	36 41.8	52 57.3
10 29 0	39 45.4	60 47.5	10 30 16.1	36 17.4	51 56.8

Duration of the eentral eclipse on the earth, 3h. 41m. 21s..1.

According to the Tables of Damoiseau and Burckhardt, the eclipse at the following places will be *annular*, and take place as follows, in mean time of the respective places : —

	Boston.	Brunswick, Me.	Cambridge Obs.
	° ′ ″	° ′	° ′ ″
Latitude,	42 21 23	43 53	42 22 48
Longitude,	71 3 37	69 55	71 7 30
	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 27 12	4 30 47	4 26 52.5
Formation of the Ring,	5 40 28	5 43 10	5 40 8.6
Least distance of centres,	41 27	44 21	41 8.8
Rupture of the Ring,	5 42 27	5 45 32	5 42 9.1
End of the Eclipse,	6 47 33	6 50 8	6 47 16.0
Duration of the Ring,	1 59	2 22	2 0.5
" " Eclipse,	2 20 21	2 19 21	2 20 23.5
At least distance. Distance of north limbs,	″ 7.25	″ 92.66	″ 7.37
At least distance. Distance of centres,	44.43	40.94	44.30
At least distance. Distance of south limbs,	96.11	10.78	95.98
Point of beginning,	° 150.5	° 151.5	° 150.5
" end,	34.0	38.1	34.0

	Concord, N. H.	Hanover, N. H.	Middlebury, Vt.
	° ′ ″	° ′ ″	° ′
Latitude,	43 12 30	43 42 26	44 0
Longitude,	71 29	72 16 45	73 10
	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 24 8	4 19 42.4	4 15 3
Formation of the Ring,	5 36 43	5 32 41.0	5 28 32
Least distance of centres,	38 38	34 38.6	30 30
Rupture of the Ring,	5 40 32	5 36 36.2	5 32 28
End of the Eclipse,	6 45 0	6 41 25.4	6 37 42
Duration of the Ring,	3 49	3 55.2	3 56
" " Eclipse,	2 20 52	2 21 43.0	2 22 39
At least distance. Distance of north limbs,	″ 39.61	″ 50.66	″ 51.33
At least distance. Distance of centres,	11.91	0.66	0.19
At least distance. Distance of south limbs,	63.43	51.98	50.99
Point of beginning,	° 150.8	° 150.7	° 150.5
" end,	35.5	36.0	35.9

	Ogdensburg, N. Y.	Portsmouth, N. H.	Scarboro' Harbor.
	° ′ ″	° ′ ″	° ′ ″
Latitude,	44 42 0	43 4 35	48 21 49
Longitude,	75 31 30	70 45 18	124 37 12
	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 2 40	4 27 47	11 22 52
Formation of the Ring,	5 17 29	5 39 55	0 57 11
Least distance of centres,	19 28	41 52	0 59 26
Rupture of the Ring,	5 21 26	5 43 47	1 1 40
End of the Eclipse,	6 27 46	6 47 54	2 33 41
Duration of the Ring,	3 57	3 52	4 29
" " Eclipse,	2 25 6	2 20 7	3 10 49
At least distance. Distance of north limbs,	″ 50.80	″ 44.32	″ 46.48
of centres,	0.16	7.35	3.37
of south limbs,	50.48	59.02	39.74
Point of beginning,	° 149.9	° 150.9	° 101.4
" end,	35.6	35.1	32.0

At the following places the eclipse will not be annular. The obscuration at Halifax, N. S., Charlottetown, P. E. I., and Montreal, being on the southern side of the sun, and at the other places on the northern.

	Charlottetown, P. E. Island.	Georgetown Obs., D. C.	Halifax, Nova Scotia.	Middletown Obs., Conn.
	° ′	° ′ ″	° ′ ″	° ′ ″
Latitude North,	46 14	38 54 26	44 39 20	41 33 8
Longitude West,	63 8	77 4 33	63 26 8	72 38 30
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 59 31	4 2 33.2	4 59 52.8	4 20 39.6
Greatest obscuration,	6 9 4	5 19 45.2	6 9 47.9	5 35 43.9
End of Eclipse,	7 12 6	6 27 28.8	7 12 59.0	6 42 21.4
Duration,	2 12 35	2 24 55.6	2 13 6.2	2 21 41.8
Point of beginning,	° 154.5	° 147.1	° 153.7	° 149.6
" end,	48.1	21.8	44.8	31.1
Digits eclipsed,	10.147	9.814	10.594	11.013

	Nantucket Obs., Mass.	New York C. H., N. Y.	Philadelphia Observatory.	Portland, Oregon.
	° ′ ″	° ′ ″	° ′ ″	° ′
Latitude North,	41 16 56	40 42 40	39 57 9	45 30.1
Longitude West,	70 5 40	74 0 30	75 10 0	122 27.5
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 33 8.8	4 15 8.9	4 10 31.8	11 31 59
Greatest obscuration,	5 46 46.0	5 30 55.8	5 26 48.8	1 11 10
End of Eclipse,	6 52 16.4	6 37 55.1	6 34 6.9	2 46 57
Duration,	2 19 7.6	2 22 46.2	2 23 35.1	3 14 58
Point of beginning,	° 150.3	° 148.9	° 148.2	° 97.9
" end,	32.6	28.2	25.6	22.0
Digits eclipsed,	11.173	10.640	10.306	10.675

	Providence Obs., R. I.	San Francisco, California.	Toronto Obs., Canada West.	Williamstown Obs., Mass.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Latitude North,	41 49 32	37 47 36	43 39 24	42 42 49
Longitude West,	71 24 15	122 26 48	79 21 30	73 12 37
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 26 14.6	11 25 3	3 44 40.6	4 16 26.0
Greatest obscuration,	5 40 38.6	1 3 59	5 3 50.0	5 31 54.5
End of Eclipse,	6 46 47.1	2 45 55	6 13 50.4	6 38 58.2
Duration,	2 20 32.5	3 20 52	2 29 9.8	2 22 32.2
	°	°	°	°
Point of beginning,	150.2	76.2	148.3	150.0
" end,	32.7	2.8	30.6	33.2
Digits eclipsed,	11.207	8.123	11.059	11.301

At *Eastham* Church, Cape Cod, Mass., in Lat. 41° 50′ 26″, Long. 69° 58′ 40″, the least distance of the centres (51″.81) will take place at $5^{h.}$ $46^{m.}$ $31^{s.}$; diff. of semidiameters 51″.94; from which it appears that the line of the southern limit of the ring passes on to the Atlantic about two miles south of Nausett lights, or in Lat. 41° 49′ 37″, Long. 69° 56′ 50″.

At *Montreal*, Canada, Lat. 45° 31′, Long. 73° 35′, the least distance, 62″.3, will be at $5^{h.}$ $26^{m.}$ $40^{s.}$; and as the difference of the semidiameters will be 51″.5 only, the eclipse will not be annular there, but probably will be so in the southwestern extremity of Montreal Island.

The village of Saratoga Springs, N. Y., Lat. 43° 3′, Long. 73° 43′, appears to be situated exactly under the line of the southern limit of the ring, as the least distance of the centres (51″.2), which occurs at $5^{h.}$ $29^{m.}$.3, is, according to the tables, the same as the difference of the semidiameters.

The difference between the *absolute* or Greenwich times of the beginning at Georgetown, New York, Boston, Brunswick, Charlottetown, &c., is quite small, or less than two minutes, or from $9^{h.}$ $10^{m.}$ $27^{s.}$ to $9^{h.}$ $12^{m.}$ $3^{s.}$ The time at any other place between them, and near the Atlantic, may therefore be easily ascertained with a good degree of accuracy, and without a direct computation, by subtracting its longitude from about $9^{h.}$ $11^{m.}$, and in this manner the time of the beginning at the following cities and towns was ascertained. The angle of the point at which the first impression will be made on the sun, or at which the eclipse will commence, is reckoned from the vertex to the right hand, and that at which the obscuration will end, from the vertex to the left (except at San Francisco, where it is also to the right), as seen through an *erect* telescope. For one that inverts, it is necessary to add 180°.

At those places marked with an asterisk, the eclipse will be annular.

Place.	Eclipse begins. P. M.	Angle from Vertex.	Place.	Eclipse begins. P. M.	Angle from Vertex.
	h. m.	°		h. m.	°
Albany, N. Y.,	4 14.0	150	N. Bedford, Mass.,	4 28.6	150
Amherst, Mass.,	4 20.2	150	*Newburyp't, Ms.,	4 27.5	151
*Andover, Mass.,	4 26.4	151	N. Haven, Conn.,	4 19.5	149
Annapolis, Md.,	4 5.0	148	Newport, R. I.,	4 27.0	150
Baltimore, Md.,	4 4.5	147	Norwich, Conn.,	4 23.5	150
Bangor, Me.,	4 36.0	153	*Plattsburg, N.Y.,	4 12.2	150
Burlington, N. J.,	4 11.7	148	Plymouth, Mass.,	4 29.3	150
*Burlington, Vt.,	4 14.3	151	*Portland, Me.,	4 29.7	151
*Dover, N. H.,	4 27.1	151	Princeton, N. J.,	4 12.5	148
Eastport, Me.,	4 43.5	153	*Provincetown, Ms.,	4 31.5	151
*Exeter, N. H.,	4 27.0	151	*Salem, Mass.,	4 27.6	151
*Gloucester, Mass.,	4 28.0	151	Springfield, Mass.,	4 20.5	150
*Lowell, Mass.,	4 25.5	151	Trenton, N. J.,	4 12.1	148
Montreal, C. E.,	4 11.3	151	West Point, N. Y.,	4 14.6	149
Newark, N. J.,	4 14.5	149	Worcester, Mass.,	4 24.1	150

Elements of the Eclipse. Mean Time at Greenwich.

Hour.	☉'s Longitude.	☉'s Lat.	☉'s Right Asc.	Declination.	Semidiam.	Sid. Time.
	° ′ ″	″	° ′ ″	° ′ ″	′ ″	h. m. s.
5	65 3 26.60	N.0.05	63 6 54.62	21 9 35.18	15 48.91	4 15 44.14
6	5 50.55	.06	9 26.47	10 1.08	48.90	15 54.00
7	8 14.50	.06	11 58.32	10 26.94	48.89	16 3.86
8	10 38.45	.07	14 30.19	10 52.77	48.89	16 13.71
9	13 2.40	.08	17 2.07	11 18.56	48.88	16 23.57
10	15 26.35	.08	19 33.97	11 44.31	48.87	16 33.43
11	17 50.30	.09	22 5.87	12 10.02	48.87	16 43.28
12	65 20 14.24	N.0.09	63 24 37.79	21 12 35.69	15 48.86	4 16 53.14

☉'s Horizontal Parallax, 8″.46 ; Obliquity, 23° 27′ 34″.1 ; Ellipticity, $\frac{1}{300}$th.

Lunar Elements by Burckhardt and Damoiseau.

Hour.	Moon's Longitude.		B. greater, D. less, by	Moon's Latitude North.		B. greater, D. less, by	Adams's Moon's Eq. Par.	Adams's Semidiameter.
	° ′ ″	′ ″	″	′ ″	′ ″	″	′ ″	′ ″
5	63 18 22.31	30 9.36	5.36	10 56.34	2 47.37	0.82	54 34.94	14 54.16
6	63 48 31.67	30 8.49	5.34	13 43.71	2 47.19	0.73	34.17	53.95
7	64 18 40.16	30 7.63	5.36	16 30.90	2 47.00	0.67	33.41	53.74
8	64 48 47.79	30 6.79	5.43	19 17.90	2 46.82	0.63	32.66	53.54
9	65 18 54.58	30 5.98	5.51	22 4.72	2 46.64	0.62	31.91	53.33
10	65 49 0.56	30 5.21	5.60	24 51.36	2 46.44	0.63	31.16	53.13
11	66 19 5.77	30 4.45	5.67	27 37.80	2 46.25	0.62	30.43	52.93
12	66 49 10.22		5.70	30 24.05		0.59	54 29.70	14 52.73

Hour.	Moon's Right Ascension.		Moon's Declination.		Damoiseau's Moon's Eq. Par.	Damoiseau's Semidiameter.
	° ′ ″	′ ″	° ′ ″	′ ″	′ ″	′ ″
5	61 14 5.22		21 0 48.77		54 33.58	14 52.49
		31 9.53		8 28.01		
6	61 45 14.75		9 16.78		32.82	52.28
		31 12.26		8 22.06		
7	62 16 27.01		17 38.84		32.07	52.07
		31 14.98		8 16.06		
8	62 47 41.99		25 54.90		31.32	51.87
		31 17.62		8 10.01		
9	63 18 59.61		34 4.91		30.58	51.67
		31 20.32		8 3.92		
10	63 50 19.93		42 8.83		29.86	51.47
		31 23.01		7 57.81		
11	64 21 42.94		50 6.64		29.16	51.28
		31 25.68		7 51.67		
12	64 53 8.62		21 57 58.31		54 28.51	14 51.10